

# **SURFACE TEXTURING USING FOLDABLE STRUCTURES AND ACTIVE MATERIAL ACTUATION**

## **CROSS REFERENCE TO RELATED APPLICATIONS**

**[0001]** The present application claims priority to and continues in part from U.S. application Ser. No. 12/761,709 entitled "ASSEMBLY FOR AND METHOD OF FORMING LOCALIZED SURFACE WRINKLES" and filed on Apr. 16, 2010, the entire scope of which is hereby incorporated by reference.

## **BACKGROUND OF THE INVENTION**

**[0002]** 1. Field of the Invention

**[0003]** The present disclosure generally relates to systems for and methods of surface texturing. More particularly, the invention pertains to a system for and method of actively modifying a surface texture using active material actuation, and foldable structures.

**[0004]** 2. Discussion of Prior Art

**[0005]** Surface texturing has long been used to affect, enable, or control various physical interaction (i.e., aspects, or conditions) of a system, including surface adhesion, reflection, coefficients of friction, structural colors, and metrology. Traditionally, once molded, machined, constructed, or otherwise produced, physical systems often present set surface textures that may be advantageous in one or more of the afore-mentioned aspects while presenting disadvantages in others. As a result, active texturing systems have been developed that enable a surface texture to be modified when desired. Conventional active systems, including various combinations of rigid structures and elastic structures having stored therein sufficient energy to buckle the structure, have been inefficient, overly complex, and in some cases limited in capability and extent. By employing conventional electro-mechanical actuation, the various limitations associated therewith (added weight, complexity, part count, etc.) also present concerns.

## **BRIEF SUMMARY OF THE INVENTION**

**[0006]** In response to the afore-mentioned concerns, the present invention recites a more efficient system for and method of actively modifying the texture of a surface, and more specifically, to a system for and method of modifying surface texture utilizing active material actuation and a foldable structure. As a result, the invention is useful for modifying the physical interactions of the system that are affected, enabled, or controlled by surface texture. More particularly, the present invention is useful for modifying, among other physical interactions, the reflective, thermal, fluidic, electromagnetic, tactile, acoustic, emissive, or aesthetic aspects/capabilities thereof. In a preferred embodiment, the invention is useful for modifying the aesthetics or feel of a surface, so as to effect a visual or haptic alert. Finally, by employing a foldable structure and active material actuation, the invention presents a less complex surface texturing solution that reduces the number of moving parts, packaging requirements, and amount of noise (both with respect to acoustic and EMF) produced.

**[0007]** In general, the invention presents a system for selectively and dynamically modifying the texture of an exposed surface. The system includes a foldable structure that is com-

municatively coupled to or defines the surface. That is to say, the structure **14** defines a plurality of folds, in the manner, for example, of origami folding. Each fold further defines a degree of folding, and presents an outermost edge or vertex. The system includes at least one active material element operable to undergo a reversible change in fundamental property when exposed to or occluded from an activation signal. The active material element is communicatively coupled to the structure, such that the change causes or enables the degrees of folding, and as a result, the texture of the surface to modify. Where actively actuated, a power supply, controller, and sensor are preferably in communication with the foldable structure and configured to selectively modify the texture of the exposed surface.

**[0008]** The disclosure, including references to vehicular applications, as well as exemplary folding structures and active material elements/actuators may be understood more readily by reference to the following detailed description of the various features of the disclosure and the examples included therein.

## **BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING**

**[0009]** A preferred embodiment(s) of the invention is described in detail below with reference to the attached drawing figures of exemplary scale, wherein:

**[0010]** FIG. **1** is a perspective view of the interior cabin of a vehicle, particularly illustrating a controlled texturing system including actively controlled textured surfaces composing the dashboard, and center console, and a shape memory wire mesh drivenly coupled to the dashboard surface, in accordance with a preferred embodiment of the invention;

**[0011]** FIG. **2a** is an elevation of an actively controlled texturing system including a foldable structure in a flattened condition caused by a singular force input, in accordance with a preferred embodiment of the invention;

**[0012]** FIG. **2b** is an elevation of the system shown in FIG. **2a**, wherein the input has been ceased and the structure is in a more folded condition;

**[0013]** FIG. **3** is a partial cross-section of an exemplary foldable structure, having a plurality of fold lines etched/formed therein, in accordance with a preferred embodiment of the invention;

**[0014]** FIG. **4** is a partial cross-section of an exemplary foldable structure, having metallic outer layers and polymeric core, in accordance with a preferred embodiment of the invention;

**[0015]** FIG. **5** is a partial elevation of an actively controlled texturing system, including a foldable structure and a plurality of actuators orthogonally engaging the structure, in accordance with a preferred embodiment of the invention;

**[0016]** FIG. **6** is a plan view of an actively controlled texturing system including a shape memory polymer structure, having a plurality of heating elements off-centered therein, a contractile wire actuator, a sensor, a power supply, and a controller communicatively coupled to the actuator, sensor, and supply, in accordance with a preferred embodiment of the invention;

**[0017]** FIG. **7** is a cross-section of an actively controlled texturing system including a foldable structure defining a flat pre-activation surface, a substrate adhered to the structure, and a shape memory wire actuator embedded within the sub-